Forest Health Protection
Pacific Southwest Region

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To: Sharon Heywood, Forest Supervisor, Shasta-Trinity National Forest

Subject: Biological Evaluation of Red Fir Restoration Project at South Fork Mountain, South Fork Management Unit (FHP Report No. N11-01)

At the request of Keli McElroy, Pete Angwin (Plant Pathologist) visited the Red Fir Restoration Project area on South Fork Mountain (South Fork Management Unit, Shasta-Trinity National Forest) on September 15, 2009 and November 4, 2010. The purpose of the visits were to assist in the development of silvicultural management prescriptions for the area. On September 15, 2009, Pete was joined by Cynthia Snyder (Entomologist) and Silviculturists Jeff Paulo and Keli McElroy. On November 4, 2010, Pete was joined by members of the Red Fir Restoration Interdisciplinary Team, including Keli McElroy, Melanie Stevens (Geologist), Mark Arnold (Archaeologist), Stephanie Joyce (Landscape Architect), Susan Erwin (Botanist) and Fred Levitan (Hydrologist).

Background

The Red Fir Restoration Project area is located on South Fork Mountain, within the Hayfork Ranger District portion of the South Fork Management Unit of the Shasta-Trinity National Forest. The treatment area covers about 1,150 acres and is bordered on the west by the Six Rivers National Forest and on the east by privately owned land. The project area runs generally along the ridge of South Fork Mountain, along National Forest Road 4N12 and 6N01, from the Racetrack north to the Blake Mountain area (approximately 17 miles long and up to 1.5 miles wide), from T1N, R6E to T4N, R5E, Humboldt Meridian.

One of the major objectives of the Red Fir Restoration Project is to maintain red fir as a viable species. The project area is designated in the Shasta-Trinity NF Land and Resource Management Plan as Matrix (timber production) and Adaptive Management Area (AMA). South of the Race Track, below the project area, much of the land is in the South Fork Late Successional Reserve.

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In 1982, Kleijunas and Wenz identified the insect and disease complex of dwarf mistletoe, Cytospora canker (*Cytospora abietis*) and the fir engraver beetle (*Scolytis ventralis*) as the primary cause of mortality in true fir in the area. Red fir was affected by red fir dwarf mistletoe, (*Arceuthobium abietinum* f.sp. *magnificae*), while white fir was infected by white fir dwarf mistletoe (*A. abietinum* f.sp. *concoloris*). Neither variety of dwarf mistletoe is capable of infecting the other species of true fir. Other insects and diseases, including other *Scolytis* species, *Pseudohylesinus* bark beetles, roundheaded fir beetle (*Tetrobium abietis*), several decay fungi (*Ganoderma oregonense, Pholiota adiposa* and *Phellinus pinicola*) were also found in the area. Heterobasidion root and butt rot (caused by *Heterobasidion occidentale* (formerly known as "S-type" of *H. annosum*, and before that, as *Fomes annosus))* was found in true fir stumps in three locations. In addition, many of the sugar pines in the area were infected with white pine blister rust (*Cronartium ribicola*). At the time, Kliejunas and Wenz stated that unless treatments to address the dwarf mistletoe/Cytospora/fir engraver beetle complex were implemented, insect and disease levels would continue to increase, resulting in further decline and mortality in the true fir.

In 1999 and into the early 2000's, discussions aimed at addressing the dwarf mistletoe/Cytospora/fir engraver beetle situation at South Fork Mountain continued sporadically. Dave Schultz (Entomologist) and I visited the area several times during that period and observed the continuing decline of the true fir in the area. Our continuing recommendation was to implement silvicultural treatments to reduce the levels of dwarf mistletoe in the stands, which in turn would reduce the impacts from Cytospora canker and fir engraver beetle. A variety of treatments were suggested according to the severity of dwarf mistletoe infestation, ranging from complete removal (clearcut or group selection) of susceptible true fir species where infestations were heaviest, to removal of the overstory and sanitation thinning of the understory where disease levels were low or moderate, to sanitation thinning of the overstory and understory where infestation levels were low. The heavily infested red fir stands near Blake's Mountain were the clearest candidates for clearcut or group harvest, though if that wasn't deemed possible, then overstory removal and very heavy sanitation thinning in the remaining understory was recommended.

Kliejunas and Wenz's assessment correctly noted that red fir dwarf mistletoe primarily infects only red fir (and not white fir), while white fir dwarf mistletoe primarily infects white and grand fir (and not red fir). However, recent work by noted dwarf mistletoe expert, Robert Mathiasen led to the finding that the variety of dwarf mistletoe on red fir on South Fork Mountain is <u>not</u> *A. abietinum* f.sp. *magnificae*, but a new host-specific variety which has been named *A. abietinum* f.sp *wienzii* (Mathiasen 2009; Mathiasen and Daugherty 2009), This new variety dwarf mistletoe, which has been named Wiens' dwarf mistletoe, readily infects red fir and brewers spruce, and <u>occasionally</u> white fir, and may be distinguished by its green-brown to red-brown shoot color, in contrast to the yellow to yellow-green shoot color of both white and red fir dwarf mistletoe (though yellow-green male plants of Wiens' dwarf mistletoe are not uncommon). However, while Wiens' dwarf mistletoe is capable of infecting whate fir, Mathiasen has indicated that its ability to do so is limited (personal communication, 2009). During his studies, he only found two locations on South Fork Mountain where the newly described dwarf mistletoe crossed over to white fir, and in those areas, only a few infected white fir were found. His opinion is that for the purposes of management, the two dwarf mistletoes should be considered host-specific

Observations

A total of eight red fir and mixed conifer stands were visited during my two visits in 2009 and 2010. In general, as one gains elevation while travelling north along FS Roads 4N12 and 6N01, from several miles south of Racetrack north to Blake Mountain, stand species composition changes from mixed conifer stands that are dominated by white fir (with lesser amounts of Douglas-fir, ponderosa pine, incense cedar and sugar pine) to mixed conifer stands that are dominated by red fir. Most of the stands north of the Racetrack are red fir-dominated, with no white fir present to the north near Blake's Mountain. Between visits in 2009 and 2010, Kelli McElroy delineated the project area into separate stand units, with similar vegetative composition and structure. Unit 20, which was visited in both trips, is a good example of a unit with no white fir and only minor amounts of sugar pine (Figure 1).

For the most part, the stands that we looked at on September 15 and November 4 were multistoried. Most had two stories and some (such as Unit 26) had three. Unit 11 was the only single-storied stand. The basal area of the stands in the project area is high, ranging from about 350 to 450 square feet per acre.

In general, the true fir in the upper stories were moderately to highly infested with dwarf mistletoe. Dwarf mistletoe ratings (DMRs) of 5 and 6 were not uncommon in individual fir at this level, and most had branch flagging from Cytospora canker (Figure 2). Although all of the stands had severely infected individual understory trees, dwarf mistletoe levels

Figure 1. Dwarf mistletoe, Cytospora canker and fir engraver beetle in red fir at South Fork Mountain, Unit 20.

Figure 2. Branch flagging due to dwarf mistletoe and Cytospora Canker at South Fork Mountain, Unit 20.

in the understory varied depending on proximity to heavily infected overstory trees. True fir regeneration in most of the stands was profuse. Almost all of the dwarf mistletoe in the red fir was red-brown in color, indicating that it was Wiens' dwarf mistletoe (Figure 3). A few yellow-green-colored male plants were also noted. According to Mathiasen, these are most likely Weins' dwarf mistletoe as well. In contrast, dwarf mistletoe in white

fir (mostly south of the Racetrack) was yellow-green or yellow in color, indicating that it was white fir dwarf mistletoe (*A. abietinum* f.sp. *concoloris*).

Figure 3. Wiens' dwarf mistletoe on red fir on South Fork Mountain, Unit 20.

Recommendations and Conclusions

Overall, the predictions that Kliejunas and Wenz made in 1982 have come true- the dwarf mistletoe/Cytospora canker/fir engraver beetle problem has gotten worse as the dwarf mistletoe has spread and intensified. Fir mortality has continued sporadically up to the present, and have been particularly prevalent during periods of drought.

My overall recommendations for the area remain the same as they were ten years ago, that the best way to address the dwarf mistletoe/Cytospora/fir engraver beetle situation is to reduce the levels of dwarf mistletoe while increasing overall stand diversity and vigor. Reduction of dwarf mistletoe levels will in turn lead to a reduction in the impacts of Cytospora canker and the fir engraver beetle. Specific prescriptions should depend on the current species composition and structure of the stand, and the amount and distribution of each variety of dwarf mistletoe that is present. Stand treatments may vary from complete clearcut/regeneration or group selection where dwarf mistletoe levels are highest, to overstory removal or shelterwood treatment/understory sanitation thin where dwarf mistletoe levels are high to moderate in the overstory and low to moderate in the understory, to a general sanitation thin where overall dwarf mistletoe levels are low. The objective should not be to completely eradicate the mistletoe; rather it should be to reduce the mistletoe to a level that will promote stand growth and vigor and prevent the stands from unraveling in the future. Complete clearcutting/regeneration harvest is only necessary in the most heavily infested stands, such as in several of the red fir stands near Blake's Mountain. General recommendations for the treatments are as follows:

- Treatments should promote species diversity and non-host species wherever possible. In units where red fir is infected and white fir is not, white fir may be retained as a non-host species. Where white fir is infected and red fir is not, red fir may be retained.

- To reduce spread of dwarf mistletoe from infested upper to uninfested lower stand levels, promote single-storied stands wherever possible.

- To minimize spread of dwarf mistletoe into treated stands, units should be as large as possible, and unit boundaries should be located as much as possible in uninfested or non-host-type areas, or along natural barriers such as roads or meadows. Concentrated planting of non-host species within 25-50-feet of unit boundaries may be considered where infested borders cannot be avoided.

- Thinning in the understory should concentrate on removing trees with the highest DMRs and lowest crown ratios. Whenever possible, strive to retain mostly 0-2 DMR firs while maintaining adequate stocking. When that is not possible, planting may be considered.

- Thinning should be done to a level where the resulting vertical growth of remaining host species is faster than the vertical spread of the dwarf mistletoe. In general, vertical tree growth should be at least three inches per year (preferably more).

- Although I have not see any fruiting bodies of *H. occidentale* in white fir stumps on South Fork Mountain, Kliejunas and Wenz reported their presence in 1982. Since the root disease pathogen is likely present in the area, treatment of freshly cut stumps 14" wide or wider with a borate compound (such as Sporax or Cellu-Treat) immediately after cutting is recommended. This will prevent the creation of new Heterobasidion root disease infection centers.

During my visit to the project area in 2010, Kelli described the treatments that are being proposed in all of the units that were visited. The proposed treatments have incorporated the above recommendations and appear to be well-matched with the stand structure and composition of each unit, as well as the severity and distribution of the dwarf mistletoe that is present. Although it would have been best if the stands had been treated years ago, the chances of successfully reducing dwarf mistletoe levels, promoting stand health and keeping the stands from unraveling appear to be good.

If you have any questions regarding this report and/or need additional information please contact me at 530-226-2436.

/s/ Pete Angwin

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CC: Keli McElroy, Melanie Stevens, Mark Arnold, Stephanie Joyce, Fred Levitan, James Gonzalez, Tom Quinn, Lori Jackson, Brad L Rust, Lois Shoemaker, Jerry Van Hees, Al Olson, Cynthia Snyder, Julie Lydick, Phil Cannon and Robert Mathiasen

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